US011669548B2

(12) **United States Patent**
Sethi et al.

(10) **Patent No.: US 11,669,548 B2**
(45) **Date of Patent: Jun. 6, 2023**

(54) **PARTIAL TABLE AND MULTISOURCE SYNCHRONIZATION FOR DATABASES**

(71) Applicant: **Formagrid Inc.**, San Francisco, CA (US)

(72) Inventors: **Raghav Sethi**, San Francisco, CA (US); **Ryan Joshua Pearl**, San Francisco, CA (US); **Jonathan Chien**, San Francisco, CA (US); **Chuan Ji**, San Francisco, CA (US); **Nenya Edjah**, San Francisco, CA (US); **Emmett Nicholas**, San Francisco, CA (US); **Jonathan Brandon Bakst**, Rolling Hills, CA (US)

(73) Assignee: **Formagrid Inc**, San Francisco, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/473,872**

(22) Filed: **Sep. 13, 2021**

(65) **Prior Publication Data**

US 2022/0083565 A1 Mar. 17, 2022

Related U.S. Application Data

(60) Provisional application No. 63/078,295, filed on Sep. 14, 2020, provisional application No. 63/165,538, filed on Mar. 24, 2021.

(51) **Int. Cl.**
G06F 16/00 (2019.01)
G06F 16/27 (2019.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G06F 16/273*** (2019.01); ***G06F 16/211*** (2019.01); ***G06F 16/215*** (2019.01); ***G06F 16/258*** (2019.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

10,430,437 B2 10/2019 Purushothaman et al.
2007/0083521 A1 * 4/2007 Diedrich H04L 67/63
(Continued)

FOREIGN PATENT DOCUMENTS

KR 10-2018-0120499 A 11/2018

OTHER PUBLICATIONS

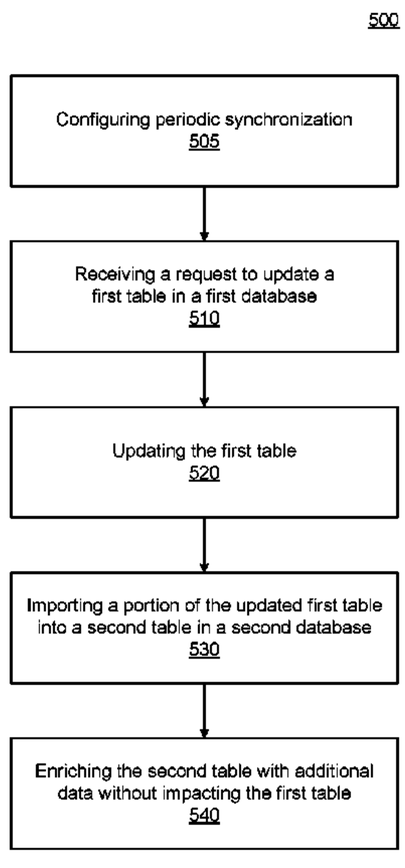
PCT International Search Report and Written Opinion, PCT Application No. PCT/IB2021/058325, dated Dec. 3, 2021, 10 pages.
(Continued)

Primary Examiner — Bai D Vu
(74) *Attorney, Agent, or Firm* — Fenwick & West LLP

(57) **ABSTRACT**

A database system provides automatic synchronization from one or more databases to a table. The synchronized portion of each source database table is periodically imported into a corresponding portion of a destination database table. For each synchronized field in the table with data from multiple source databases, one of the source databases is set as a primary source, which determines the data type and field configuration of the field. Data from secondary sources are cast to the data type established by the primary source and represented using the primary source's field configuration. The source database table may also include data that is not synchronized with the destination database table. Similarly, the destination database table may be enriched with data that is not included in the source database table.

16 Claims, 7 Drawing Sheets



(51) **Int. Cl.**

G06F 16/25	(2019.01)
G06F 16/21	(2019.01)
G06F 16/215	(2019.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2010/0228768	A1*	9/2010	Yamasuge	G06F 16/273 709/219
2010/0274759	A1	10/2010	Takeuchi et al.	
2011/0004668	A1	1/2011	Salmon et al.	
2012/0008971	A1	4/2012	Rakowski et al.	
2013/0166507	A1*	6/2013	Staczek	H04L 67/1095 707/625
2016/0210202	A1	7/2016	Sinha	
2016/0277494	A1*	9/2016	Ito	H04L 69/28
2020/0409977	A1*	12/2020	Yang	G06F 8/61
2022/0012265	A1	1/2022	Salame	

OTHER PUBLICATIONS

United States Office Action, U.S. Appl. No. 17/692,943, dated May 11, 2022, 10 pages.

* cited by examiner

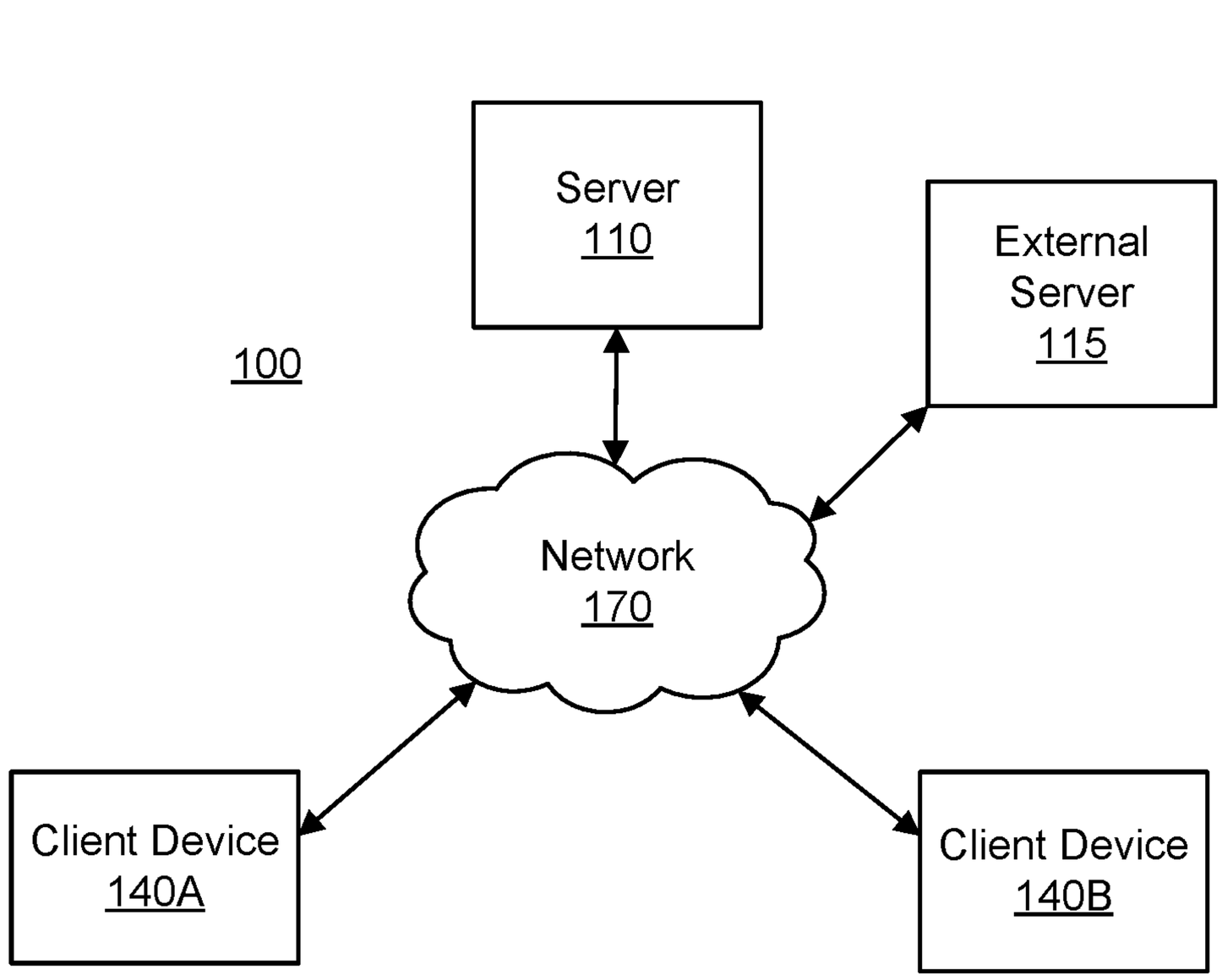

100
Server
110
External
Server
115
Network
170
Client Device
140A
Client Device
140B

FIG. 1

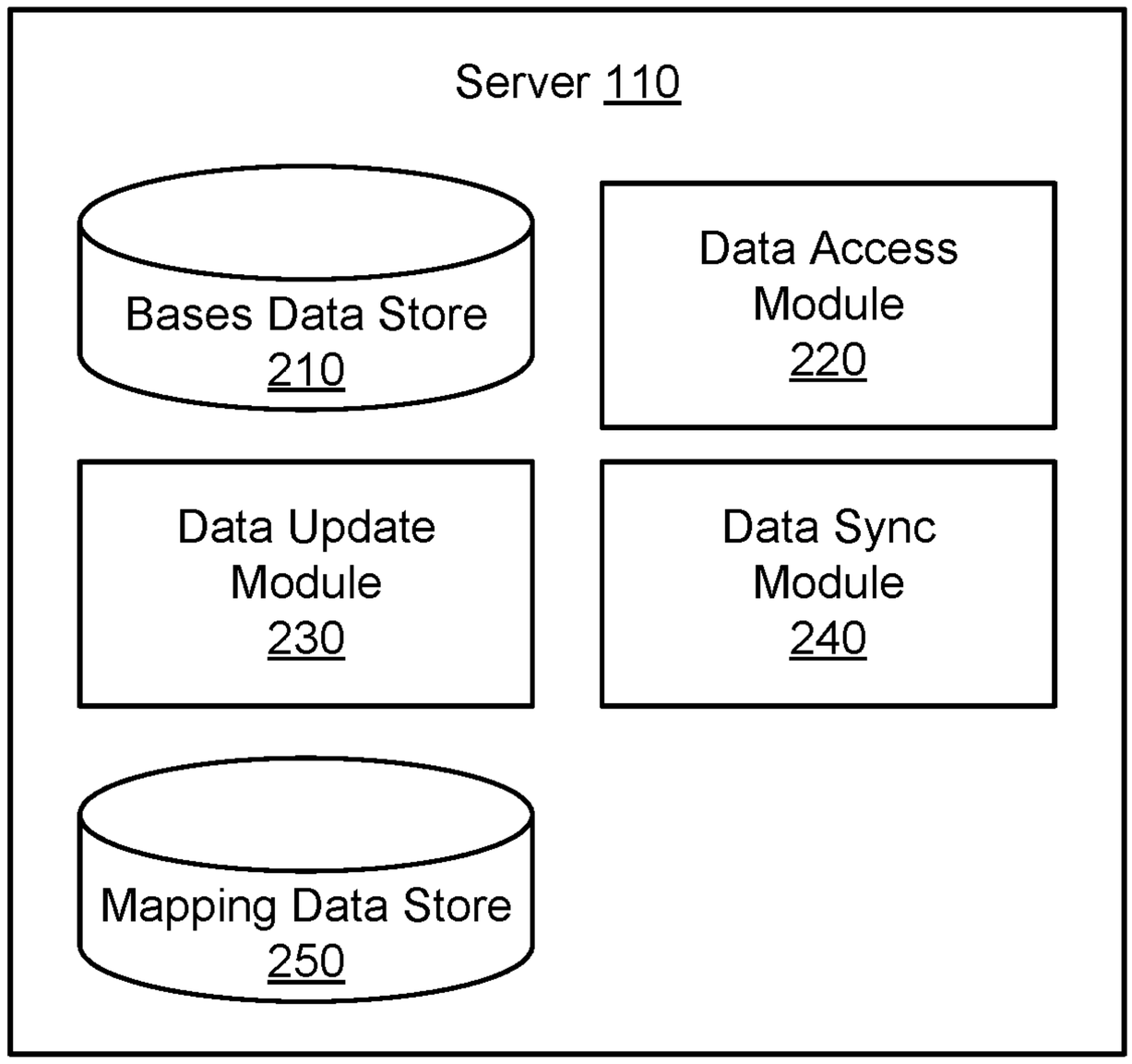

Server 110
Bases Data Store
210
Data Access
Module
220
Data Update
Module
230
Data Sync
Module
240
Mapping Data Store
250

FIG. 2

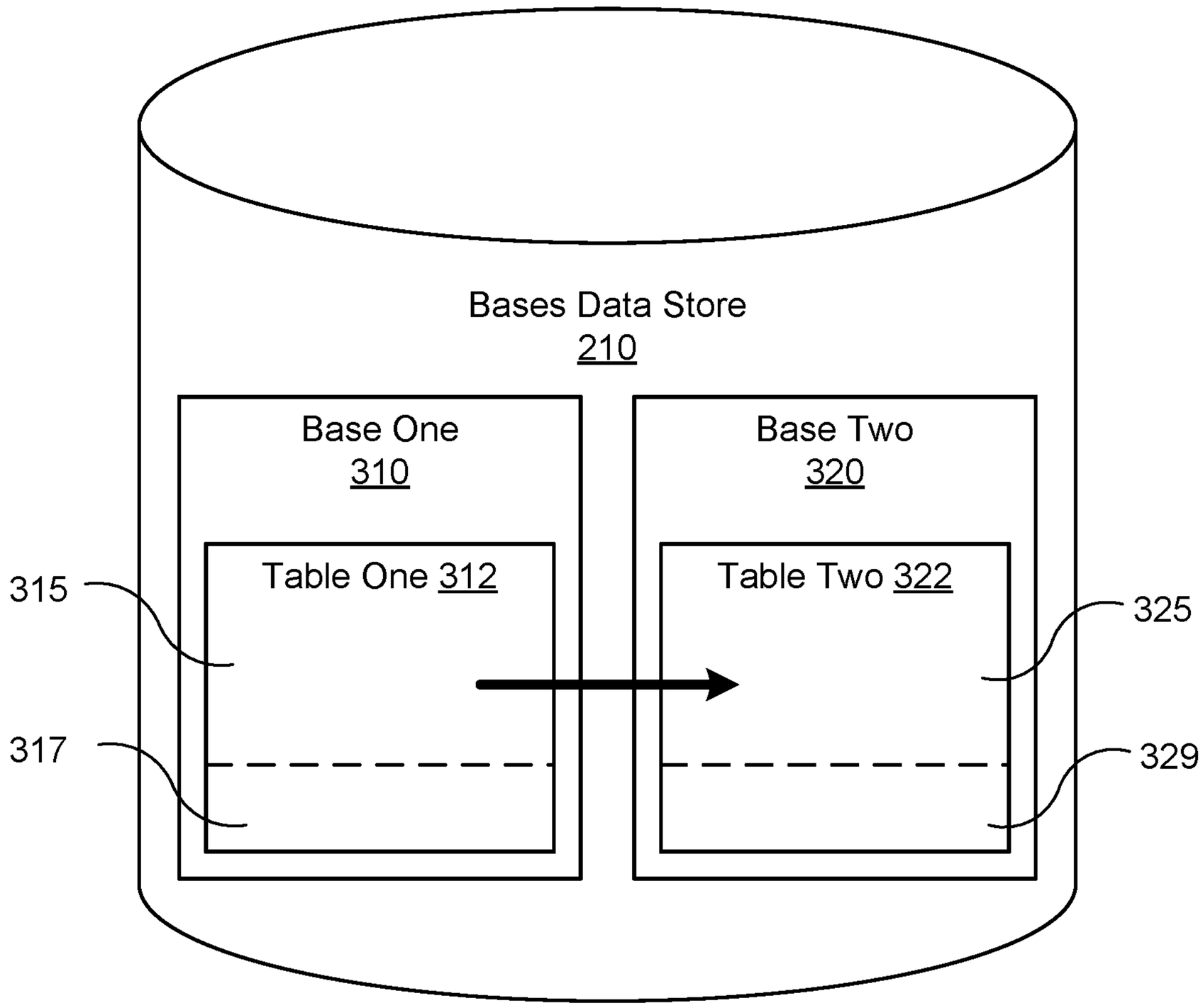

Bases Data Store
210
Base One
310
Table One 312
Base Two
320
Table Two 322
315
317
325
329

FIG. 3

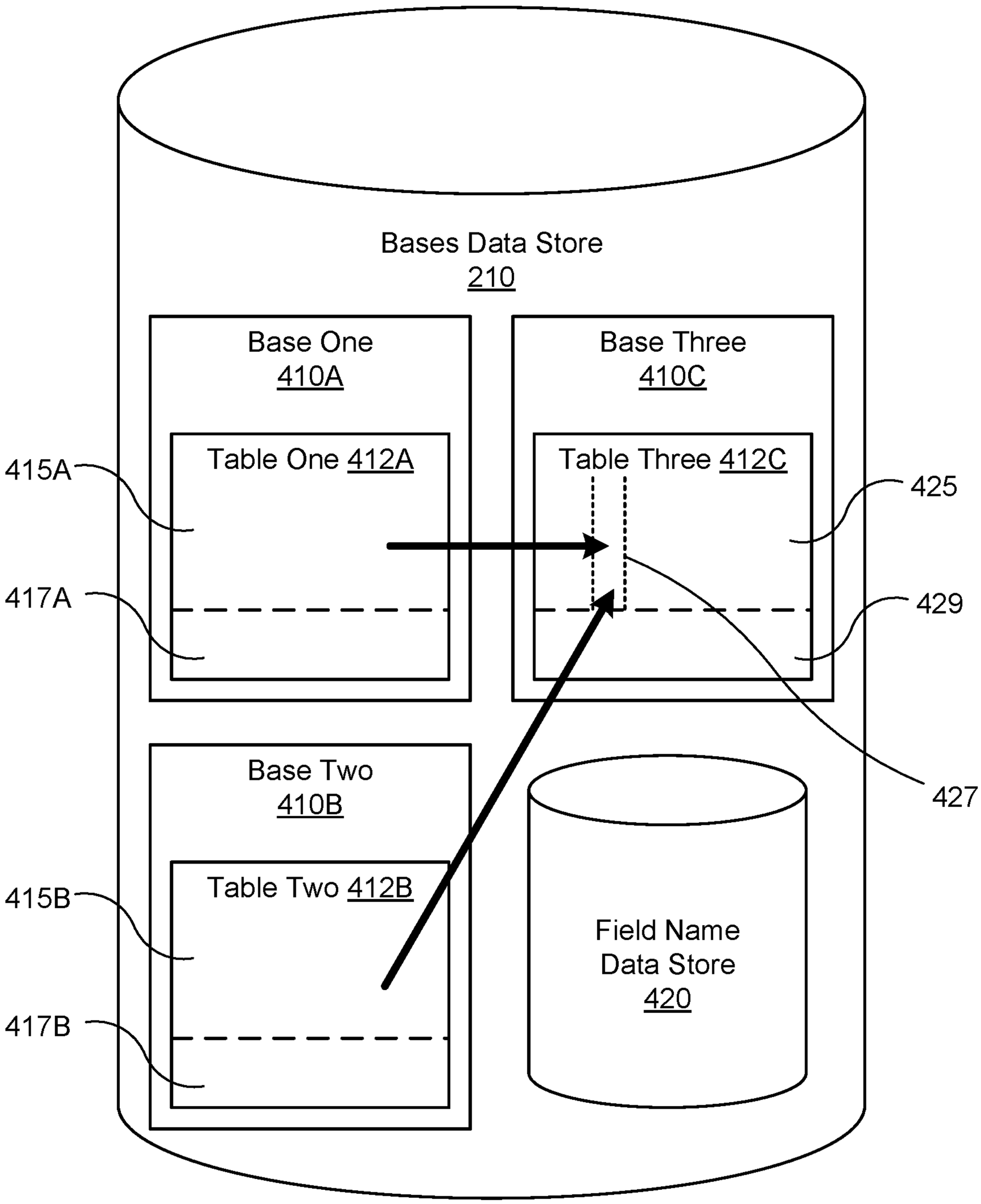

Bases Data Store
210
Base One
410A
Table One 412A
Base Three
410C
Table Three 412C
Base Two
410B
Table Two 412B
Field Name
Data Store
420
415A
417A
415B
417B
425
429
427

FIG. 4

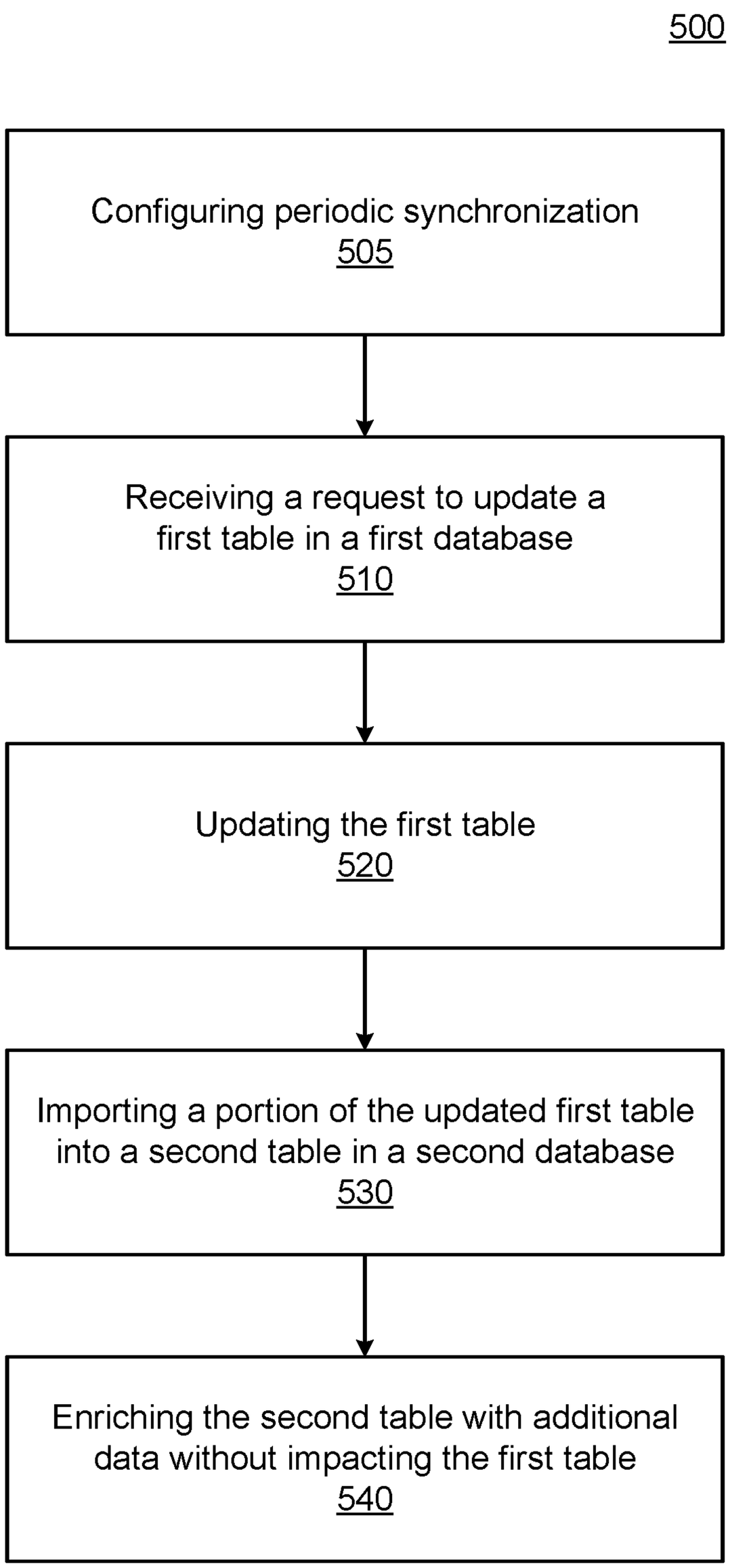

500
Configuring periodic synchronization
505
Receiving a request to update a first table in a first database
510
Updating the first table
520
Importing a portion of the updated first table into a second table in a second database
530
Enriching the second table with additional data without impacting the first table
540

FIG. 5

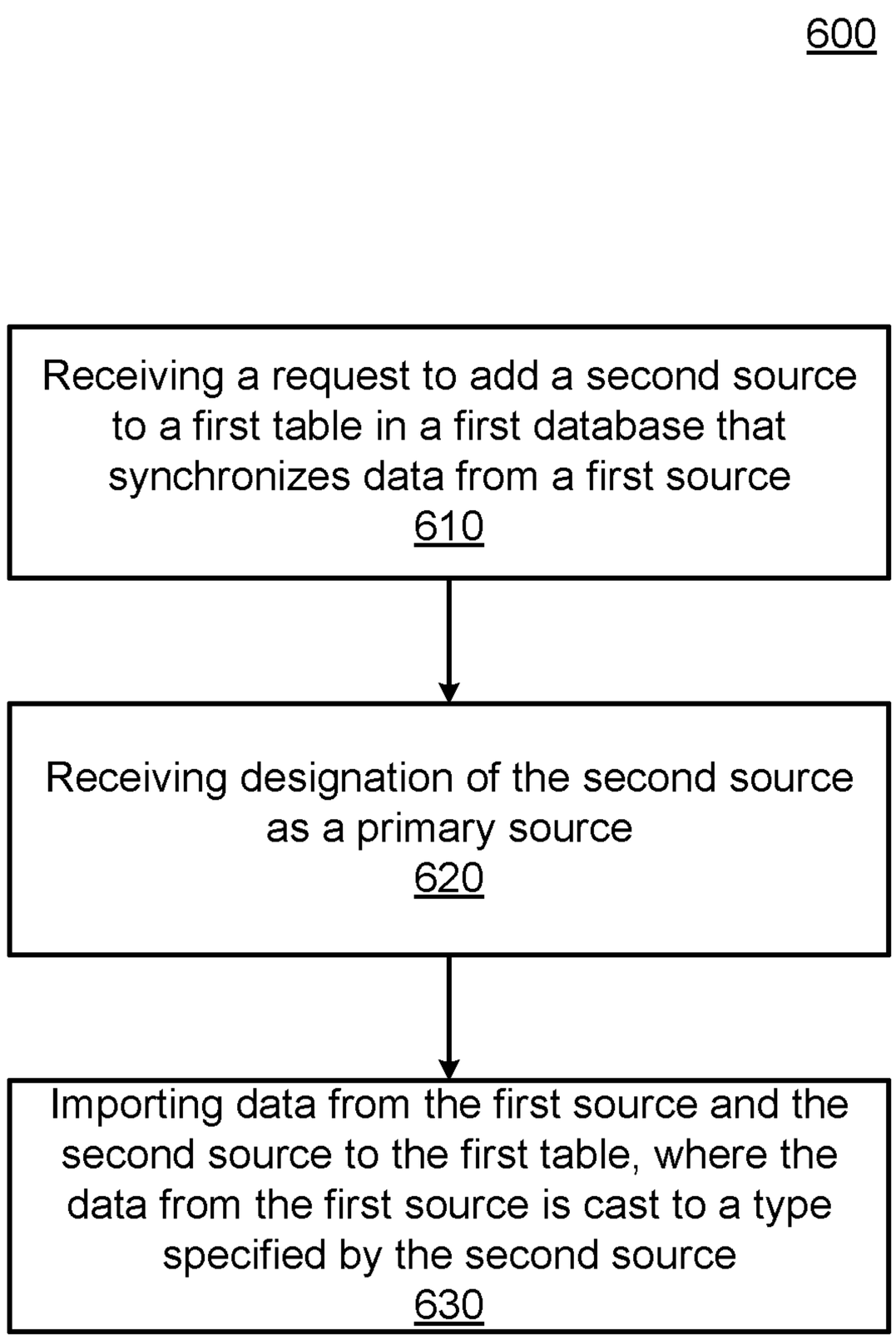

600
Receiving a request to add a second source to a first table in a first database that synchronizes data from a first source
610
Receiving designation of the second source as a primary source
620
Importing data from the first source and the second source to the first table, where the data from the first source is cast to a type specified by the second source
630

FIG. 6

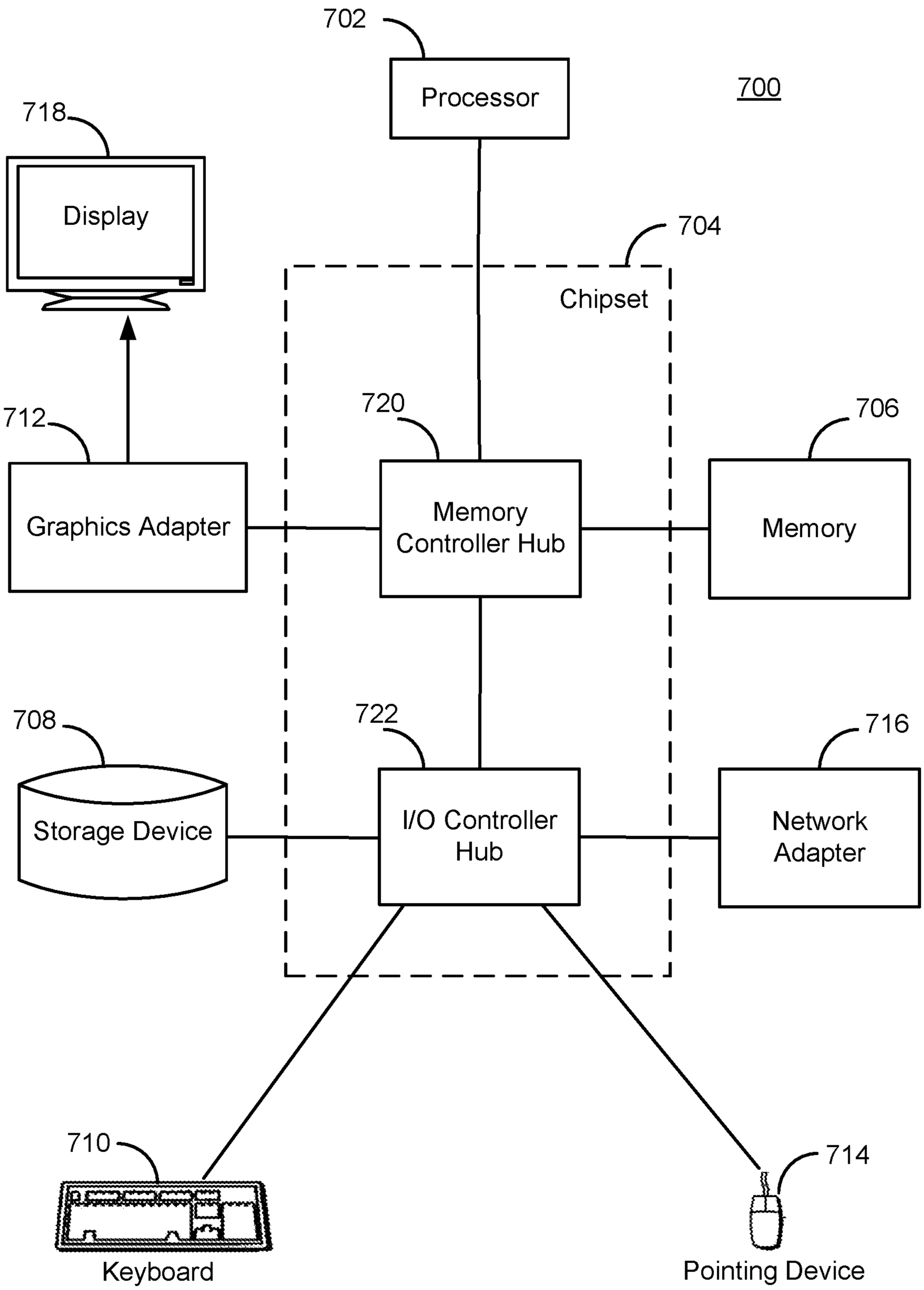

702
Processor
700
718
Display
704
Chipset
712
Graphics Adapter
720
Memory Controller Hub
706
Memory
708
Storage Device
722
I/O Controller Hub
716
Network Adapter
710
Keyboard
714
Pointing Device

FIG. 7

PARTIAL TABLE AND MULTISOURCE SYNCHRONIZATION FOR DATABASES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 63/078,295, filed Sep. 14, 2020, and U.S. Provisional Application No. 63/165,538, filed Mar. 24, 2021, each of which is incorporated by reference.

BACKGROUND

1. Technical Field

The subject matter described relates generally to databases and, in particular, to techniques for synchronizing data from one or more sources to a data table.

2. Background Information

Enterprises and other entities often provide different users with access permission to different subsets of the data available to the entity. As a result, entities typically maintain multiple databases that include partially overlapping data. Maintaining consistency between the overlapping portions can be a time-consuming and error prone task. For example, if a human is responsible for entering new data into multiple databases, typographical and other errors may lead to discrepancies between different versions of the data. One approach to addressing this problem is to store the data in a single database and control which users have access to which records but maintaining the access permissions in this scenario is also a time-consuming process. This process is also subject to error. For example, human error in updating permissions may reveal confidential data to users who are not authorized to access it.

Maintaining a database that includes data from several sources can be especially time-consuming and error prone. When an attribute in the database includes data taken from multiple sources, data loss can occur when different sources have different data types or different labels for the attribute.

SUMMARY

The above and other problems may be addressed by a database system that provides automatic synchronization from one or more databases to a table. The synchronized portion of each source database table may be periodically (e.g., once every five minutes, once an hour, etc.) imported into a corresponding portion of a destination database table. For each synchronized field in the table with data from multiple source databases, one of the source databases is set as a primary source, which determines the data type and field configuration of the field. Data from secondary sources are cast to the data type established by the primary source and represented using the primary source's field configuration.

The source database table may also include data that is not synchronized with the destination database table. Similarly, the destination database table may be enriched with data that is not included in the source database table.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a networked computing environment suitable for providing partially synchronized database tables, according to one embodiment.

FIG. **2** is a block diagram of the server of FIG. **1**, according to one embodiment.

FIG. **3** is a block diagram of the bases data store of FIG. **2**, according to one embodiment.

FIG. **4** illustrates multisource synchronization of three tables of three databases in the bases data store **210**, according to one embodiment.

FIG. **5** is a flowchart of a method for partially synchronizing database tables, according to one embodiment.

FIG. **6** illustrates a method for multisource synchronizing database tables, according to one embodiment.

FIG. **7** is a block diagram illustrating an example of a computer suitable for use in the networked computing environment of FIG. **1**, according to one embodiment.

DETAILED DESCRIPTION

The figures and the following description describe certain embodiments by way of illustration only. One skilled in the art will readily recognize from the following description that alternative embodiments of the structures and methods may be employed without departing from the principles described. Wherever practicable, similar or like reference numbers are used in the figures to indicate similar or like functionality. Where elements share a common numeral followed by a different letter, this indicates the elements are similar or identical. A reference to the numeral alone generally refers to any one or any combination of such elements, unless the context indicates otherwise.

The techniques described herein provide for data synchronization among various data tables, whether local or external, such that the data in a synchronized data table is consistent and up to date. Synchronized data tables can be used to allow various groups of users to manage and evolve their databases and workflows independently, while still being able to collaborate on shared data tables where data from various sources is aggregated. Furthermore, this may provide data synchronization with fewer transcription errors than existing approaches.

The described techniques also provide for increased data security. For example, synchronized tables provide for limited data visibility, where access can be limited to particular users or groups. Synchronized tables enable a user to share, on a limited basis, particular subsets of data from the user's database with other users, internal or external, and the user can set, on a user-by-user or per-domain basis, read and write permissions to the shared data in the synchronized table. As these permissions are set for the synchronized table, any edits to the synchronized table do not affect the user's source table, preserving the integrity of the user's database. A synchronized data table can be used to expose particular up-to-date data to external users, e.g., from different organizations, with tight control over the schedule on which the data updates, and the ability to revoke data sharing, thus balancing collaboration and security in inter-organizational sharing.

These and other benefits can be recognized in view of the present disclosure.

Example Systems

FIG. **1** illustrates one embodiment of a networked computing environment **100** suitable for providing partially synchronized database tables. In the embodiment shown, the networked computing environment **100** includes a server **110**, an external server **115**, a first client device **140**A, and a second client device **140**B, all connected via a network

170. Although two client devices **140** are shown, the networked computing environment **100** can include any number of client devices **140**. Similarly, although one external server **115** is shown, the networked computing environment **100** can include any number of external servers **115**. In other embodiments, the networked computing environment **100** includes different or additional elements. In addition, the functions described herein may be distributed among the elements in a different manner than described.

The server **110** hosts multiple databases and performs synchronization between databases with a cross-base synchronize function. The cross-base synchronize function copies data from a shared source view to a target table. Data may be copied in one direction during a synchronization. When a synchronization completes, the target table contains all of the rows in the source view and cell data for all columns (alternatively, "fields") selected to be synchronized. In one embodiment, only data (rows and columns) that are explicitly or implicitly set as 'visible' in the shared view can be copied. Users may determine what data is available to synchronize (and in what form) using a shared view interface (e.g., to designate one or more rows or columns as visible or not visible). As described in further detail below, a user can synchronize some or all data from one or more sources to a target table, and one or more of the sources can be external to the server **110**, e.g., may be hosted by an external server **115**.

In an embodiment, data in the target table matches the format of the data in the shared view interface. For example, if linked records are rendered as text in shared views, they also render as text in the target table. Formulas may render as their result type and look like a non-formula field. As a consequence of this design, synchronization does not differentiate between data being deleted from the source table or simply being hidden from the shared view. As described in further detail below, matching data from source to target table can follow an alternative technique.

The following table illustrates the mapping between source and target data types for one embodiment:

Source type	Target type
Number/date/single-line text/long text/rich text/select/multi-select	Identical type and configuration (e.g. number/date formatting, select color and order)
Foreign key	Text
Collaborator/Multi-collaborator	Text
Lookups	As the looked-up type (so synchronizing a lookup of a foreign key will result in text)
Formulas/Rollups	As the result type
Button fields	'Open URL' type button fields will be synchronized as URL field
Attachments	As-is

A synchronized target table mirrors the contents of its source view but can contain additional unsynchronized columns to enrich the synchronized data. For example, one might collect T-shirt sizes for all employees by synchronizing into the target table a list of employees and then adding an unsynchronized 'T-shirt size' column, where each employee enriches the target table by entering their T-shirt size to a respective row at the 'T-shirt size' column.

In an embodiment, users of the target table are not allowed to create or destroy records in the synchronized portion of the table, nor to change cell values or column type and type options for any synchronized column, but they can make changes to non-synchronized columns. In some embodiments, users of the target table may change the names and descriptions for synchronized columns, which does not impact the source table (i.e., source view) but changes how the synchronized data is displayed in the target table (e.g., a column in the target table has a different name than the corresponding column in the source table).

Various embodiments of the server **110** are described in greater detail below, with reference to FIG. **2**.

The client devices **140** are computing devices with which users can access and edit the databases managed by the server **110**. Example client devices include desktop computers, laptop computers, smartphones, tablets, etc. The client devices **140** may enable users to interact with the databases via a user interface accessed via a browser, a dedicated software application executing on the client devices, or any other suitable software.

The external server **115** is a server, which may be associated with a different entity than the server **110**. For example, server **110** is associated with a first organization, and server **115** is associated with a second organization. The external server **115** may be, for example, a SALESFORCE server, a JIRA server, a GOOGLE CALENDAR server, or a BOX server. Users of client devices **140** can synchronize data from source tables in databases hosted at the external server **115** to target tables at the server **110**. This can involve the user providing credential information, which the server **110** uses to connect to the external server **115**.

The server **110** can synchronize data from the external server **115** to a target table in a database of the server **110**. In one embodiment, the server **110** stores a tabular data mapping to translate data from the external server **115** to a usable format for server **110** databases. The server **110** may store a different tabular data mapping for each of multiple external servers **115** to facilitate data transfer to the target table. For example, the server **110** may store a first tabular data mapping for SALESFORCE reports that uses a SALESFORCE application programming interface (API), a second tabular data mapping for JIRA issue filters that uses a JIRA API, and a third tabular data mapping for GOOGLE CALENDAR events that uses a GOOGLE CALENDAR API. Using the API of an external server **115**, the server **110** can request and receive synchronized data for a target table. For example, the server **110** may send a query to the external server **115** using a respective API function, where the query specifies the data to be synchronized to the target table, and then the server **110** receives, via a different API function, query results including the synchronized data from the external server **115**. The server **110** identifies an external server **115**, fetches the respective tabular datamapping, and uses the respective tabular data mapping to synchronize data from the external server **115** (e.g., to a target table).

The network **170** provides the communication channels via which the other elements of the networked computing environment **100** communicate. The network **170** can include any combination of local area and wide area networks, using wired or wireless communication systems. In one embodiment, the network **170** uses standard communications technologies and protocols. For example, the network **170** can include communication links using technologies such as Ethernet, 802.11, worldwide interoperability for microwave access (WiMAX), 3G, 4G, 5G, code division multiple access (CDMA), digital subscriber line (DSL), etc. Examples of networking protocols used for communicating via the network **170** include multiprotocol label switching (MPLS), transmission control protocol/Internet protocol (TCP/IP), hypertext transport protocol (HTTP), simple mail transfer protocol (SMTP), and file transfer protocol (FTP).

Data exchanged over the network **170** may be represented using any suitable format, such as hypertext markup language (HTML) or extensible markup language (XML). In some embodiments, all or some of the communication links of the network **170** may be encrypted using any suitable technique or techniques.

Embodiments of various techniques of the networked computing environment **100** will now be described. Alternative techniques may be employed without departing from the principles set forth herein.

A user of client device **140**A can interface with the server **110** to create a synchronized target table according to one or more techniques, depending upon the embodiment. The user interface may be exposed by the server **110** or client device **140**A. In one embodiment, the user receives a link to a shared view (e.g., from an administrator of the database including the shared view). The user provides an instruction the server **110** to use the link to initiate a synchronization, either with a new table or an existing table. The server **110** sets up the requested synchronization between the shared view and the selected table. In one embodiment, the user selects a widget of a user interface exposed by the server **110** that displays a shared view to create a new synchronized table using the shared view.

In an embodiment, the link to the shared view may be temporary, e.g., only useable once, or for a finite period of time, such as 24 hours. Thereafter, the source table may be identified by a source table identifier. In this manner, the source table can be secured, such that if the user ends synchronization to the target table, the link cannot be used to inappropriately gain access the source table. In an embodiment, a user that shares a like to a shared view to another user may revoke access to the shared view from the other user.

In one embodiment, the user has access permission to the source table and the target table. The user can create a new shared view or enable synchronization of an already-existing shared view. The user can then proceed with one of the above techniques. Alternatively, the user can navigate to a user interface that displays the target table and select a widget to expose a list of potential source tables. The user can select the shared view to use it as a source table. In various embodiments, the user can set a table (e.g., for which the user has access permission) as able to be synchronized (i.e., can be used as a source table) or not. In various embodiments, the user can designate some or all of the rows or columns in the table as able to be synchronized or not.

In an embodiment, the user can restrict access to the table such that it is password protected. Additionally or alternatively, the user can restrict access to the table such that only users associated with specified email addresses or email domains can access the table.

In one embodiment, if a source table is password-protected, the user initiating synchronization to a target table is prompted to correctly enter the password to the source table in order to set up the synchronization. Once the password has been entered, synchronization may operate automatically, indefinitely, or for a predetermined time period (e.g., one month or one year) without requiring password reentry. If the password changes, or if a password is added to a previously unprotected source table, the synchronization stops working until authenticated or reauthenticated. In an embodiment, the user can revoke access temporarily or permanently.

In one embodiment, if a source table is email domain-protected, the user initiating the synchronization needs to have a verified email with a permissioned domain in order to set up the synchronization. If the initiating user's email address with the permissioned domain is deactivated, suspended, or otherwise made inactive, the synchronization may cease to operate. Alternatively, a synchronization may remain operational as long as any user of the target table has an email address with a permissioned domain.

In an embodiment, the user can add one or more external source tables to a synchronized table by selecting an external source widget in the user interface. The user can then pick another source type (e.g. AIRTABLE, SALESFORCE, or JIRA), select the source table within that type, and then map the fields from the new source table to the fields in the existing table. For each column in the target table, the user interface displays a list of columns in the source table, from which the user can select one column in the source table to associate with the column in the target table (e.g., such that data from the column in the source table is synchronized to the respective column in the target table).

In some embodiments, when adding a new source, the server **110** tries to match column names to existing column names, as described in further detail below. For columns that cannot be matched, the default option may be to synchronize that data to a new column in the target table instead. The user can change any mappings or opt to synchronize any source column to a new synchronized column.

In an embodiment, an option to select all columns is not available when there are multiple synchronization sources. When the user adds a new source table, if an existing source table is configured to synchronize all columns, that source table is changed to synchronize specific columns only. The user can use the user interface to alter the field mapping by selecting a widget to change mappings. In an embodiment, synchronized target tables that do not synchronize from multiple source tables do not include a field mapping. Rather, the target table uses the fields of the source synchronization table.

In an embodiment, after a synchronization is initiated for a target table from a source table, for every source table field, the user can select a new target table field in a dropdown of the user interface to change the target table field associated with the source table field.

Alternatively or additionally, the user can uncheck a field in the user interface to stop synchronizing data from this source table to the mapped target table field, where, if this source table was the primary source, the synchronized target table column will be destroyed.

Alternatively or additionally, the user can synchronize to a new target table field, where if the source table field was previously mapped to a target table field and the source table was the primary source, the synchronized field may be destroyed, and the data mapped to a new field instead. If the source table was not the primary source, the data may be mapped to a new field. If the source table field was previously unmapped, the data in the source table field may be mapped to a new target table field.

In an embodiment, the user can reconfigure, using the user interface, a selection of one or more columns to synchronize to a target table from a source table. Alternatively or additionally, the user can reconfigure a synchronization frequency with which the target table synchronizes to the source table.

Alternatively or additionally, the user can reconfigure whether deleted or hidden rows in the source table are deleted in the target table, where if the user does not choose to delete rows, rows will remain in the target table even after they are deleted in the source table (these rows can be removed by the user).

Alternatively or additionally, the user can remove a source table, which removes all rows associated with the source table. Alternatively or additionally, the user can turn off synchronization functionality for the target table, which converts the target table into a normal (e.g., unsynchronized) data table.

Alternatively or additionally, the user can undo a reconfiguration, which restores the previous set of selected fields, the old synchronize frequency, the old row deletion setting, and so on; however, the availability of the fields and the cell values in the fields remains up to date, since the values come from the source table, and as such they are not reverted to their data from before the reconfiguration.

Alternatively or additionally, the user can trigger a manual synchronization by clicking a widget of the user interface to initiate a synchronization. The user can do this even when the table is configured to synchronize automatically. This allows the user to synchronize the target table without having to wait for the next scheduled synchronization.

In an embodiment, removing all synchronizations to source tables from a target table causes the target table to convert into a normal table that is not synchronized. No data is removed from the target table, but no future changes to source tables are synchronized to the target table. Depending upon the embodiment, this action may not be able to be undone.

In one embodiment, a user can add a button field to the target table and set label text and a color of their choice, where the button links to the source table. When another user clicks this button, the source table opens to the corresponding record in the source table in a new tab of the user interface (if the other user has access permission). For another user that has access to both the source table and target table, the other user can view unsynchronized fields of that source table or make changes to the source table. If the user has configured the target table to not delete rows that are hidden or deleted in the source table, the button may be unable to be selected or visually distinguished when the source record is hidden or deleted. Depending upon the embodiment, formulas or view filters may consume the output of the button field, e.g., the output of the button field can be a link of the source table's record, or null if the source table's record is no longer available.

In one embodiment, if a target table is duplicated, the duplicate table has the same configuration as the original target table. If the user deletes a target table, then restores it, the target table may regain its original configuration from before its deletion.

In an embodiment, the user can change one or more column names or descriptions of the synchronized portion of the target table. This can be used to rename columns to be more appropriate for the target table, for example. In an embodiment, when a user hovers over a column icon in the user interface, they can see the name of the respective source table column (if the target column has a different name). Depending upon the embodiment, the user may or may not be able to add a row, destroy a row, reconfigure a synchronized column, or edit a cell in a synchronized column.

The following table illustrates a correspondence of actions taken upon a source table and responsive changes in a target table subsequent to a synchronization, according to one embodiment:

Source table action	Target table behavior on next synchronization
Destroy/hide column	Destroy column
Undestroy/unhide column	Undestroy column if possible/else create a new column.
Add column	If 'synchronize all fields' is enabled, add column
Add row	Row will be added to the target table
Destroy/hide row	If 'synchronize deletions' is enabled: destroy row Otherwise: the "open source record" button gets disabled
Change cell values	Change cell values (based on type conversion)
Change filters	The set of visible rows will be synchronized
Reorder rows	No impact
Change column configuration to unsupported type/configuration	Destroy column
Change column configuration to supported type/configuration	Change column config (based on type conversion)
Disable synchronizing	Synchronizing stops working
Re-enable synchronizing	Synchronizing resumes
Delete view	Synchronizing stops working
Undestroy view	Synchronizing resumes
Change share URL	Synchronizing stops, requires re-authentication
Add/change shared view password	Synchronizing stops, requires re-authentication
Add domain restriction that the user does not satisfy	Synchronizing stops, requires re-authentication by a user in the target table with the appropriate domain

In an embodiment, synchronization may be two-directional between two tables, where each table acts as a source table and a target table, and synchronized data added to either table is propagated to the other upon a subsequent synchronization.

In an embodiment, a user can generate a view-only link to send to another user, which the other user can use to view the target table only (i.e., the other user cannot edit the target table). Alternatively or additionally, the user can set a user (e.g., by identifier or email address) or a domain as view-only, where the respective one or more users can view but not edit the target table.

In an embodiment, if a field mapping from one source table column to one target table column is removed (e.g., by the user), then added back, the server **110** attempts to restore the same column (thus restoring any lookups that reference that column, or calendars that use it as the date field, etc.). If the server **110** cannot restore the original column, a new column is created instead.

In an embodiment, if a field of a source table was previously synchronized but has since been made unable to be synchronized (e.g., by an administrator of the source table), the user interface may display the source table column as visually distinct (e.g., faded out or an alternative color) than other source table columns. The user can toggle whether to synchronize currently unavailable fields, though they do not appear when the user toggles them on. Only fields that are currently available from the source table, along with any currently selected but unavailable fields, appear in the field list.

FIG. **2** illustrates one embodiment of the server **110**. In the embodiment shown, the server **110** includes a bases data store **210**, a data access module **220**, a data update module **230**, a data synchronize module **240**, and a mapping data store **250**. In other embodiments, the server **110** includes

different or additional elements. In addition, the functions may be distributed among the elements in a different manner than described.

The bases data store **210** includes one or more computer-readable media that store the one or more databases managed by the server **110**. Although the bases data store **210** is shown as a single element within the server **110** for convenience, the bases data store **210** may be distributed across multiple computing devices (e.g., as a distributed database). Similarly, individual databases may be hosted by client devices **140** (or other computing devices) with the server **110** managing synchronization between databases but not storing the databases themselves.

The data access module **220** provides a mechanism for users to access data in one or more databases. In one embodiment, the data access module **220** receives a request from a client device **140** indicating an identifier of the requesting user (e.g., a username or user identifier) and data from a specified table in a specified database that the user wishes to view. The data access module **220** determines whether the user has permission to access the requested data and, if so, provides it to the client device **140** from which the request was received for display to the user.

The data update module **230** provides a mechanism for creators and their collaborators to edit data in and add data to databases. In one embodiment, the data update module **230** receives a request from a client device **140** indicating an identifier of the requesting user and data to be added to or amended into a specified table in a specified database. The data update module **230** determines whether the requesting user has permission to edit the specified table and, if so, updates the specified table in the bases data store **210** as requested.

The data synchronize module **240** updates some or all portions of target tables to synchronize them with the corresponding source table (or tables). In one embodiment, the data synchronize module **240** periodically (e.g., for a length of time ranging from one second to one hour, such as every five minutes, every hour, etc.) checks the one or more source tables and, if there is updated data available, imports it into the corresponding one or more target tables (e.g., updates records in the target table with respective records from the source table). Additionally or alternatively, users of a target table may force a manual synchronization to one or more source tables (e.g., by selecting a control in the user interface).

The mapping data store **250** includes one or more computer-readable media that store tabular data mappings for one or more external servers **115**. Although the mapping data store **250** is shown as a single element within the server **110** for convenience, the mapping data store **250** may be distributed across multiple computing devices (e.g., as a distributed database).

A user with suitable permissions to a pair of databases may select a subset of the data in a table in one database (e.g., a source table) to synchronize with a corresponding table in a second database (e.g., a target table). Thus, the two tables are referred to as partially synchronized, as only a subset of the rows or columns from the source table are used to populate the target table. However, it should be noted that complete synchronization is also possible, meaning all of the source table is synchronized with the destination table, and the destination table has not been enriched with any additional data (though it may be, depending upon the embodiment). As described below, a user can synchronize some or all data from multiple source databases to one table at one database.

FIG. **3** illustrates the partial synchronization of two tables of two databases in the bases data store **210**, according to one embodiment. In the embodiment shown, the bases data store **210** includes base one **310** and base two **320**. In practice, the bases data store **210** will likely include many more (e.g., hundreds, thousands, or even millions of) bases. Base one **310** includes table one **312**, which has a synchronized portion **315** and an unsynchronized portion **317**. Base two **320** includes table two **322**, which includes a synchronized portion **325** (which mirrors the synchronized portion **315** of table one **312** except for any differences that arose since the previous synchronization operation) and an enriched portion **329**. The enriched portion **329** may include data added by users of base two **320**, data synchronized from a third table, or both.

The third table in such a case may either be another table in base one **310** or from a third base (not shown). It should be noted that table two **322** is not limited to receiving synchronized data from just two tables. In theory, table two **322** may receive synchronized data from an unlimited number of other tables, limited only by computational and memory requirements. Similarly, synchronization is not limited to a single generation. Table two **322** may serve as a source table for a third destination table, which may in turn serve as a source table for another target table, etc. Furthermore, each synchronization relationship between a source table and a target table may share a different subset of data selected from either the synchronized portion **325**, the enriched portion **329**, or both.

FIG. **4** illustrates multisource synchronization of three tables of three databases in the bases data store **210**, according to one embodiment. In the embodiment shown, the bases data store **210** includes base one **410**A, base two **410**B, base three **410**C, and a field name data store **420**. Base one **410**A includes table one **412**A, which has a synchronized portion **415**A and an unsynchronized portion **417**A. Base two **410**B likewise includes table two **412**B, which has a synchronized portion **415**B and an unsynchronized portion **417**B. The field name data store **420** stores mappings between potential field names that have a high likelihood of being synonymous (e.g., "first name" and "given name"). The bases data store **210** may include additional bases or tables, depending upon the embodiment.

Base three **410**C includes table three **412**C, which includes a synchronized portion **425** and an enriched portion **429**. The enriched portion **429** may include data added by users of base two **410**B, data synchronized from a fourth table, or both. For example, the server **110** may receive user input data (e.g., data that a user input to a client device **140** and sent to the server **110**) specifying additional one or more rows or columns to add to table three **410**C.

In this embodiment, table three **412**C includes a column **427** that synchronizes data from two sources, table one **412**A and table two **412**B. For example, column **427** includes ten records total, six received from table one **412**A and four from table two **412**B. A user administrating table three **412**C (e.g., using a client device **140**) sets table one **412**A as the primary source. Depending upon the embodiment, the primary source may be automatically set by the server **110**, e.g., based on which source is first synchronized to the column **427**, or which source provides the most records to the column **427**; the automatically set primary source may be updated by the user, in some embodiments. Source tables other than the primary source may be considered secondary sources.

The server **110** uses the primary source to determine the data type of the column **427**. Data from other sources, e.g.,

table two **412**B, is cast to the data type of the data from the primary source in the column. This resolves ambiguities which may arise from synchronizing columns of multiple source tables with different data types to one column in a target table.

For example, the column synchronized from table one **412**A to the column **427** may have a data type "text," where the column synchronized from table two **412**B to the column **427** may have a data type "date." Because table one **412**A is the primary source, the server **110** sets column **427** as having data type "text" and casts data from table two **412**B for column **427** as "text."

The server **110** may also determine the field configuration for the column **427** based on the respective field configuration of the column at the primary source from which data is synchronized. In one embodiment, the primary source determines whether the column in the target table is removed when the source table's column is hidden or destroyed. For example, if a column of a primary source is removed from the source table, the server **110** removes the respective column from the target table, but if the corresponding column is removed from a different source table, only records in the target table corresponding to the different source table are affected (e.g., removed). For a target table with a single source table, the single source table can be considered to be the primary source for all fields.

The user also performs field mapping for synchronized fields from table one **412**A and table two **412**B to table three **412**C. In the field mapping, the user sets a correspondence between a column at each source to a column at table three **412**C. The server **110** initially attempts to match fields from sources to table three **412**C according to field name, which the user can override via a user interface. The server **110** compares field names from synchronized columns of a source (e.g., table one **412**A) to field names of synchronized columns in the target table (e.g., table three **412**C) and, upon identifying a matching pair, maps the source field to the target field.

For example, table one **412**A may include a "first name" field and a "last name" field, table two **412**B may include a "given name" field, a "middle name" field, and a "surname" field, and table three **412**C may include a "first name" field and a "family name" field. The server **110** matches the "first name" field from table one **412**A to the "first name" field from table three **412**C, indicating that data from the "first name" field of table one **412**A will synchronize to the "first name" field of table three **412**C. The user maps the "given name" field of table two **412**B to the "first name" field of table three **412**C, and the "last name" field of table one **412**A and the "surname" field of table two **412**B to the "family name" field of table three **412**C. As such, data from table one **412**A and table **412**B will synchronize to the mapped fields in table three **412**C.

In an embodiment, the server **110** auto-matches columns with synonymous field names, as determined according to the field name data store **420**. The field name data includes mappings between field names that are likely to be synonymous. Thus, the server **110** can use the field name data to identify columns with different but synonymous names as likely matches. The matches can be automatically applied or presented to the user as suggestions for verification.

Example Methods

FIG. **5** illustrates a method **500** for partially synchronizing database tables, according to one embodiment. The steps of FIG. **5** are illustrated from the perspective of the server **110** performing the method **500**. However, some or all of the steps may be performed by other entities or components. In addition, some embodiments may perform the steps in parallel, perform the steps in different orders, or perform different steps.

In the embodiment shown in FIG. **5**, the method **500** begins with the server **110** configuring **505** a periodic synchronization between a first database and a second database. This may be prompted by the server **110** receiving a request to do so. The server **110** receives **510** a request to update a first table in a first database. The server **110** updates **520** the first table as requested. As part of a synchronization operation (either periodic or manually triggered), the server **110** imports **530** a portion of the updated first table into a corresponding portion of a second table in a second database. Depending upon the embodiment, the portion of the updated first table imported **530** to the second table may include only the subset of data of the updated first table that has changed since a previous synchronization operation, or the portion may include all data designated for synchronization from the first table to the second table. The server **110** also enriches **540** the second table with additional data without impacting the first table. As described previously, the additional data may be imported from another table, entered by a user of the second database, or both.

FIG. **6** illustrates a method **600** for multisource synchronizing database tables, according to one embodiment. The steps of FIG. **6** are illustrated from the perspective of the server **110** performing the method **600**. However, some or all of the steps may be performed by other entities or components. In addition, some embodiments may perform the steps in parallel, perform the steps in different orders, or perform different steps.

In the embodiment shown in FIG. **6**, the method **600** begins with the server **110** receiving **610** a request to add a second source to a first table in a first database that synchronizes data from a first source. The server **110** receives **620** a designation of the second source as a primary source. As such, data from the first source that is synchronized to portions of the first table where data from the second source also syncs will be cast to the data type of the data received from the second source for that portion and configured according to a field configuration of the data received from the second source for that portion. The server **110** imports **630** data from the first source and the second source to the first table, where data from the first source is cast to the type specified by the second source.

Computing System Architecture

FIG. **7** is a block diagram illustrating an example computer **700** suitable for use as the server **110** or a client device **140**. The example computer **700** includes at least one processor **702** coupled to a chipset **704**. The chipset **704** includes a memory controller hub **720** and an input/output (I/O) controller hub **722**. A memory **706** and a graphics adapter **712** are coupled to the memory controller hub **720**, and a display **718** is coupled to the graphics adapter **712**. A storage device **708**, keyboard **710**, pointing device **714**, and network adapter **716** are coupled to the I/O controller hub **722**. Other embodiments of the computer **700** have different architectures.

In the embodiment shown in FIG. **7**, the storage device **708** is a non-transitory computer-readable storage medium such as a hard drive, compact disk read-only memory (CD-ROM), DVD, or a solid-state memory device. The memory **706** holds instructions and data used by the processor **702**. The pointing device **714** is a mouse, track ball, touchscreen, or other type of pointing device, and is used in

combination with the keyboard **710** (which may be an on-screen keyboard) to input data into the computer system **700**. The graphics adapter **712** displays images and other information on the display **718**. The network adapter **716** couples the computer system **700** to one or more computer networks.

The types of computers used by the entities of FIGS. **1** through **4** can vary depending upon the embodiment and the processing power required by the entity. For example, the server **110** might include a distributed database system comprising multiple blade servers working together to provide the functionality described. Furthermore, the computers can lack some of the components described above, such as keyboards **710**, graphics adapters **712**, and displays **718**.

Additional Considerations

In various embodiments, aggregated synchronization can also be referred to as multisource synchronization.

Some portions of above description describe the embodiments in terms of algorithmic processes or operations. These algorithmic descriptions and representations are commonly used by those skilled in the computing arts to convey the substance of their work effectively to others skilled in the art. These operations, while described functionally, computationally, or logically, are understood to be implemented by computer programs comprising instructions for execution by a processor or equivalent electrical circuits, microcode, or the like. Furthermore, it has also proven convenient at times, to refer to these arrangements of functional operations as modules, without loss of generality.

As used herein, any reference to "one embodiment" or "an embodiment" means that a particular element, feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment. The appearances of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment. Similarly, use of "a" or "an" preceding an element or component is done merely for convenience. This description should be understood to mean that one or more of the elements or components are present unless it is obvious that it is meant otherwise.

Where values are described as "approximate" or "substantially" (or their derivatives), such values should be construed as accurate +/−10% unless another meaning is apparent from the context. From example, "approximately ten" should be understood to mean "in a range from nine to eleven."

As used herein, the terms "comprises," "comprising," "includes," "including," "has," "having" or any other variation thereof, are intended to cover a non-exclusive inclusion. For example, a process, method, article, or apparatus that comprises a list of elements is not necessarily limited to only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. Further, unless expressly stated to the contrary, "or" refers to an inclusive or and not to an exclusive or. For example, a condition A or B is satisfied by any one of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

Upon reading this disclosure, those of skill in the art will appreciate still additional alternative structural and functional designs for a system and a process for providing partial synchronization of database tables. Thus, while particular embodiments and applications have been illustrated and described, it is to be understood that the described subject matter is not limited to the precise construction and components disclosed. The scope of protection should be limited only by the following claims.

What is claimed is:

1. A computer-implemented method for data synchronization, comprising:

receiving, by a server, a request to synchronize data from a first database to a third database, the first database including data arranged in rows and columns, wherein the request identifies a first set of data in the first database to synchronize to the third database;

receiving, by a server, a request to synchronize data from a second database to a third database, the second database including data arranged in rows and columns, wherein the request identifies a second set of data in the second database to synchronize to the third database, the second set of data not included in the first database;

configuring, by the server, a first periodic extraction of the first set of data from the first database to the third database;

configuring, by the server, a second periodic extraction of the second set of data from the second database to the third database;

receiving, by the server, a change to the first set of data in the first database;

receiving, by the server, a change to the second set of data in the second database; and

propagating, by the server as part of a next instance of the first periodic extraction, the change to the first set of data in the first database to the third database;

propagating, by the server as part of a next instance of the second periodic extraction, the change to the second set of data in the second database to the third database;

wherein the third database includes a synchronized portion and an unsynchronized portion, the synchronized portion including the first set of data from the first database and the second set of data from the second database, and the unsynchronized portion including data not extracted from the first database or the second database.

2. The computer-implemented method of claim **1**, further comprising:

receiving, by the server, a request to synchronize a third set of data from the first database to the second database, wherein the third set of data comprises at least a portion of the second set of data; and

configuring, by the server, a third periodic extraction of the third set of data from the first database to the second database.

3. The computer-implemented method of claim **1**, wherein a period of the first periodic extraction is a length of time ranging from one second to one hour.

4. The computer-implemented method of claim **1**, wherein the first database is at an external server, the method further comprising:

identifying, by the server, the external server;

fetching, by the server, a tabular data mapping for the external server; and

synchronizing, by the server, data from the external server using the tabular data mapping.

5. The computer-implemented method of claim **1**, further comprising:

receiving, by the server, from a user associated with the third database, a new set of data to add to the unsynchronized portion of the third database; and

adding, by the server, the new set of data to the unsynchronized portion of the third database, wherein the first database or the second database does not include the new set of data.

6. The computer-implemented method of claim **1**, further comprising:

setting, by the server, one of the first database or the second database as a primary source; and

casting, by the server, a data type of a particular column in the third database that includes data from both the first database and the second database, as a data type of the primary source.

7. The computer-implemented method of claim **6**, further comprising:

casting, by the server, a field configuration of the particular column in the third database as a field configuration of the primary source.

8. The computer-implemented method of claim **1**, wherein the first database is access-limited to a first set of users and the third database is access-limited to a second set of users comprising at least one user not in the first set of users.

9. The computer-implemented method of claim **1**, wherein configuring, by the server, the first periodic extraction of the first set of data from the first database to the third database, comprises:

receiving, by the server, a field mapping of fields in the first database to fields in the third database, wherein data in a field of the first database is periodically propagated to a mapped field in the third database.

10. The computer-implemented method of claim **1**, wherein configuring, by the server, the first periodic synchronization of the first set of data from the first database to the third database, comprises:

determining, by the server, a field mapping of fields in the first database to fields in the third database, wherein data in a field of the first database is periodically propagated to a mapped field in the third database.

11. The computer-implemented method of claim **10**, wherein determining the field mapping comprises:

matching, by the server, a name of the field in the first database to a name of the mapped field in the third database.

12. The computer-implemented method of claim **1**, further comprising:

receiving, by the server, a request to end the first periodic extraction of the first database to the third database; and

terminating, by the server, the first periodic extraction, wherein the third database retains its data as of a most recent instance of the first periodic extraction before the termination of the first periodic extraction.

13. The computer-implemented method of claim **1**, wherein the first database further includes a second synchronized portion, the second synchronized portion including a view of the second database that is periodically extracted from the second database.

14. The computer-implemented method of claim **13**, wherein the first database is a primary source and the third database is a secondary source, further comprising casting, by the server, data of the view of the secondary source to a data type of the view from the primary source in the synchronized portion.

15. The computer-implemented method of claim **1**, further comprising a fourth database including a second synchronized portion, wherein the second synchronized portion includes a view of the third database that includes at least some of the first set of data periodically extracted from the first database.

16. A multisource partially synchronized database system comprising:

one or more processors and one or more non-transitory computer-readable media storing:

a first database including data arranged into rows and columns;

a second database including data arranged into rows and columns; and

a third database including a synchronized portion and an unsynchronized portion,

wherein the synchronized portion includes a first view of the first database that is periodically extracted by the one or more processors from the first database and a second view of the second database that is periodically extracted by the one or more processors from the second database,

wherein the first database is a primary source and the second database is a secondary source, data in the third database synchronized from the secondary source being cast to a data type specified by the primary source, and

wherein the unsynchronized portion includes data provided by the third set of users.

* * * * *